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FIELD EVALUATION OF TWO TYPES OF FLAME BURNER MOUNTINGS[1/]

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The use of a full mechanization program in cotton production resulted in a saving of approximately $38 per acre over a 2-year period covering 1954 and 1955 in the Yazoo-Mississippi Delta (1,2).[3/] Of this total saving, approximately $4 was attributed to mechanical and chemical weed control practices. With the general acceptance of chemicals for weed control early in the season and the growing use of lay-by chemicals for late-season control, flame cultivation is becoming an increasingly important mid-season control method in a fully mechanized weed control program.

The rising popularity of flame cultivation may be attributed to a combination of many factors, some of which are:

1. The availability of low-cost liquefied petroleum gases.
2. Development of the flat-type "Stoneville" burner by Jones (3) and the modified "Arkansas" burner by Stanton (4).
3. Shortage of labor during critical periods.
4. The desire to fully mechanize, thus reducing the cost of producing farm crops, particularly cotton.
5. Research on flame patterns, burner settings, application techniques for early-season weed control, and other factors (5,6).[4/]

1/ The work described was done in cooperation with the Delta Branch, Miss. Agricultural Experiment Station, Stoneville, Miss., and is part of a contributing project to Regional Cotton Mechanization Project S-2.

2/ Agricultural Engineers, Agricultural Engineering Research Division, Agricultural Research Service, United States Department of Agriculture.

3/ Figures in parentheses refer to Literature Cited at end of this publication.

4/ Stephenson, K. Q., Flame Gradients in the Field, Unpublished data presented in the Southern Regional Cotton Mechanization Project S-2 - Annual Report 1958.

The problem: Even with the many advancements in the principle of flame cultivation, there is a need to reduce the cost of the operation. There is also a need to develop a better method of adjusting and controlling burner position in relation to the individual row.

Conventional flame cultivators utilize a skid for carrying two burners, one for each side of the row (Fig. 1). With both burners set the same, any difference in row heights will change the path of the flame in relation to the plant and cause the flame to strike the plant foliage, thereby shielding the grass and burning the leaves of the plants (Fig. 2). It is possible, therefore, that a more accurate control of the flame may be realized by mounting the burners so that they are independent of each other.

Figure 1. Conventional flame burner mount. Gaging is from skid in row middle.

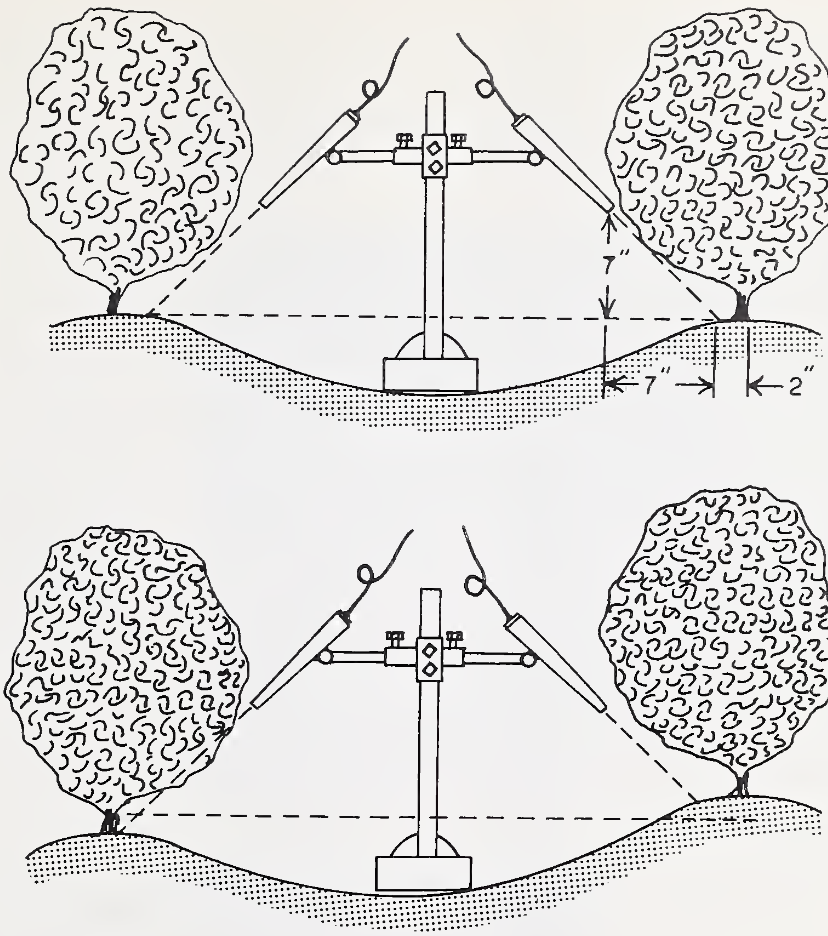

Figure 2. How a difference in row heights affects the flame path in relation to the plant. Skid-mounted burners are set for rows of equal height (top). A difference of 3 inches in row heights will cause the flame to strike the base of the plant on one side and prematurely on the other side (bottom).

Equipment and Procedure: Flame burner attachments were designed to mount on conventional parallel-action, rear-mounted cultivator gangs similar to earlier front cultivator mountings (7). Figure 3 shows burner mount on cultivator employing standard clamps with wedge bolts. Figure 4 shows burner mount on cultivator that has an offset split clamp. Details of the burner mount are shown in figure 5.

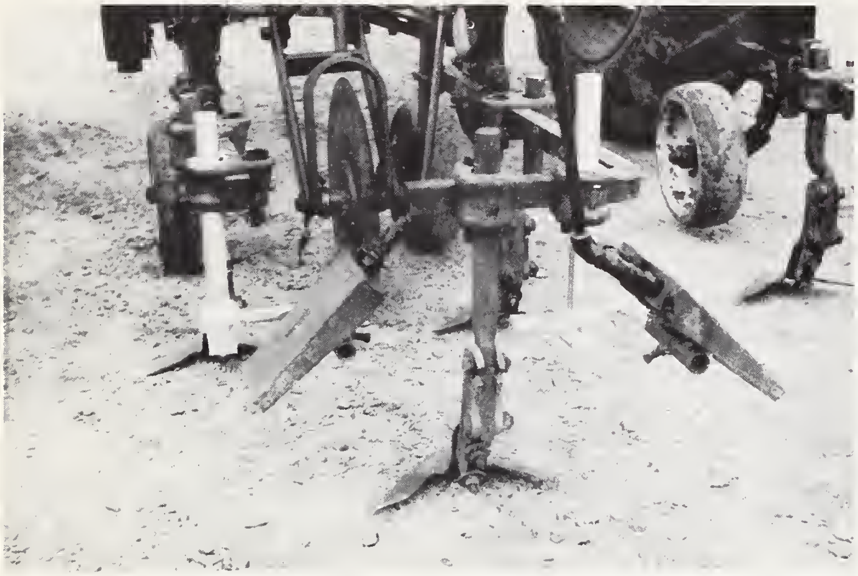

Figure 3. Flame burner mounts on cultivator using wedge-bolt type standard clamps. Note that mounts can be used either as right or left by rotation in standard clamp.

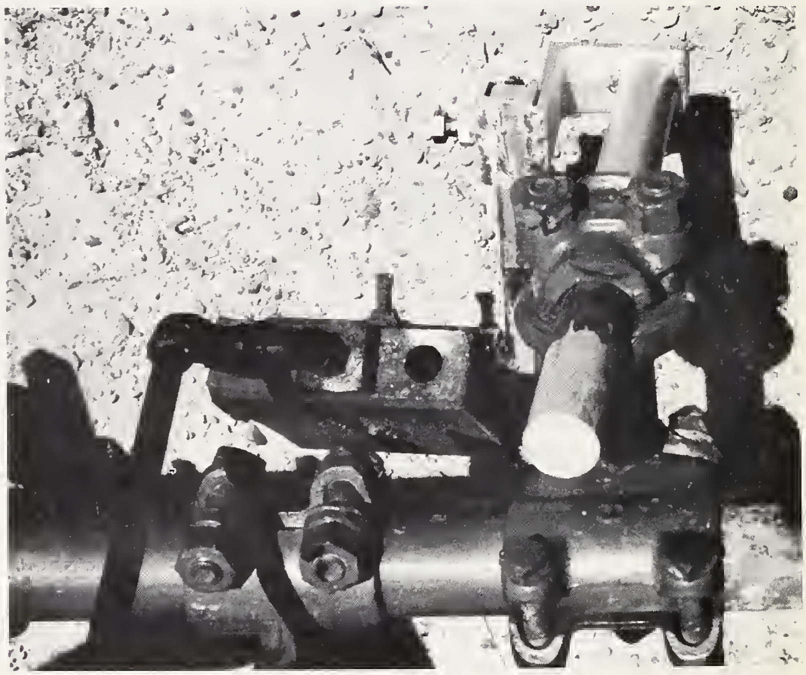

Figure 4. Side view of burner mount on cultivator with split standard clamps.

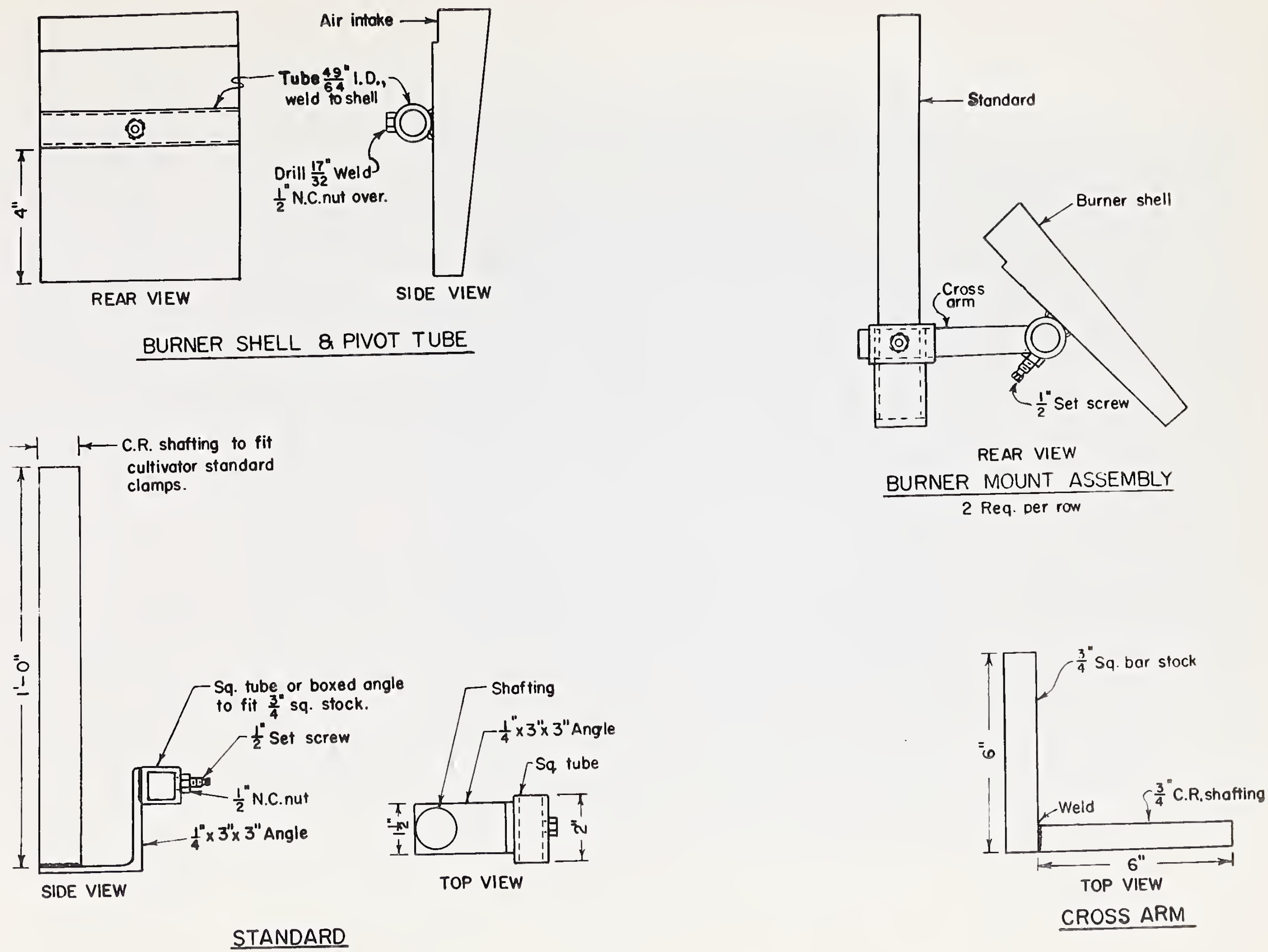

Figure 5. Schematic diagram showing flame burner mount assembly.

The gage wheel on each gang permits the burner to remain in its "set" position in relation to the burner side of the row. The flexibility of the mounting allows for burner adjustment in any desired direction.

Early cultivation is usually accomplished with five sweeps per middle. As the plants grow, usually only three sweeps are used to the middle. This leaves two standard clamps for mounting the burner standards on the cultivator beam (Fig. 3).

The flame cultivator fuel tank was mounted on the front of the tractor as shown in figure 6.

Figure 6. Combination rear-mounted cultivator with flame cultivator. Gas manifold is supported by main beam of cultivator. Gas is conducted to individual burners with hoses. Fuel tank for burner is mounted forward of tractor radiator. (Tanks over rear axles are for experimental herbicide work.)

The experimental flame-plus-conventional cultivator was compared with a standard flame cultivator with skid-mounted burners. Field measurements of temperatures were made with temperature-indicating lacquers. Lacquers, which would melt at 175°, 200°, 225°, and 250° F., were painted on one side of 12-inch garden stakes. To determine the temperature distribution within the flame (Figure 7) the stakes were then positioned upright on the center of the row, 2 inches off center and 4 inches off center.

Figure 7. Garden stakes coated with temperature-indicating lacquer at 0, 2, and 4 inches from drill.

The selection of the lacquer as a means of measuring temperatures was influenced by Stephenson's earlier success[5] in using the temperature-indicating lacquer technique as a means of determining in-the-field temperature gradients for different flame burner settings.

The distance from the row and the slope of all burners was set in the shop on a line diagram. The height of all burners in relation to the row was set in the field. The tractors on which the two flame cultivators were mounted were calibrated for a speed of 3 miles per hour. All burners were equipped with number 2-2403 nozzle tips. The painted stakes were placed on four consecutive rows with the lacquer always facing the same direction. A second set of stakes was placed in exactly the same spot as the first set after the first cultivator had made its pass. This procedure was followed for burners set at two angles with the horizontal--30° and 45°. Burners were operated at 40 p.s.i. (pounds per square inch) throughout the test.

Results: Table 1 lists the average heights above the soil surface at which the designated temperatures existed when the burners were set at a 30° angle with the horizontal plane. These heights were not significantly

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5/ See footnote 4, page 1.

affected by the method of mounting the burners, the temperature at which the lacquer melted, nor the distance from the center of the row at which the temperatures were taken. Based on these data, one might expect temperatures ranging from 175° to 250°F. to exist within a vertical plane with boundaries 4 inches high on the plant and extending 4 inches from the cotton plant. As shown in figure 8, these temperatures existed across a relatively narrow band. From the standpoint of temperature distribution, the experimental mounted burner performed as well as the conventionally mounted burner at 30° angle settings in rows that were fairly uniform in height.

Table 1. Height from soil surface at which designated temperature existed when burners were set at a 30° angle with the horizontal plane, Stoneville, Miss., July 1961.[1/]

Flame cultivator	Temperature	Distance from center of row		
		0	4	Average
	°F.	in.	in.	in.
Experimental				
burner mounting	175	3.8	3.5	3.6
	200	3.9	3.8	3.8
	225	5.0	3.9	4.4
	250	3.3	4.1	3.7
				3.9
Conventional				
burner mounting	175	4.3	4.3	4.3
	200	4.4	4.4	4.4
	225	5.1	4.2	4.7
	250	3.8	4.4	4.1
				4.4

1/ Average over 4 consecutive rows. The heights were not significantly affected by the cultivator, the temperature at which the lacquer melted, or the distance from the center of the row.

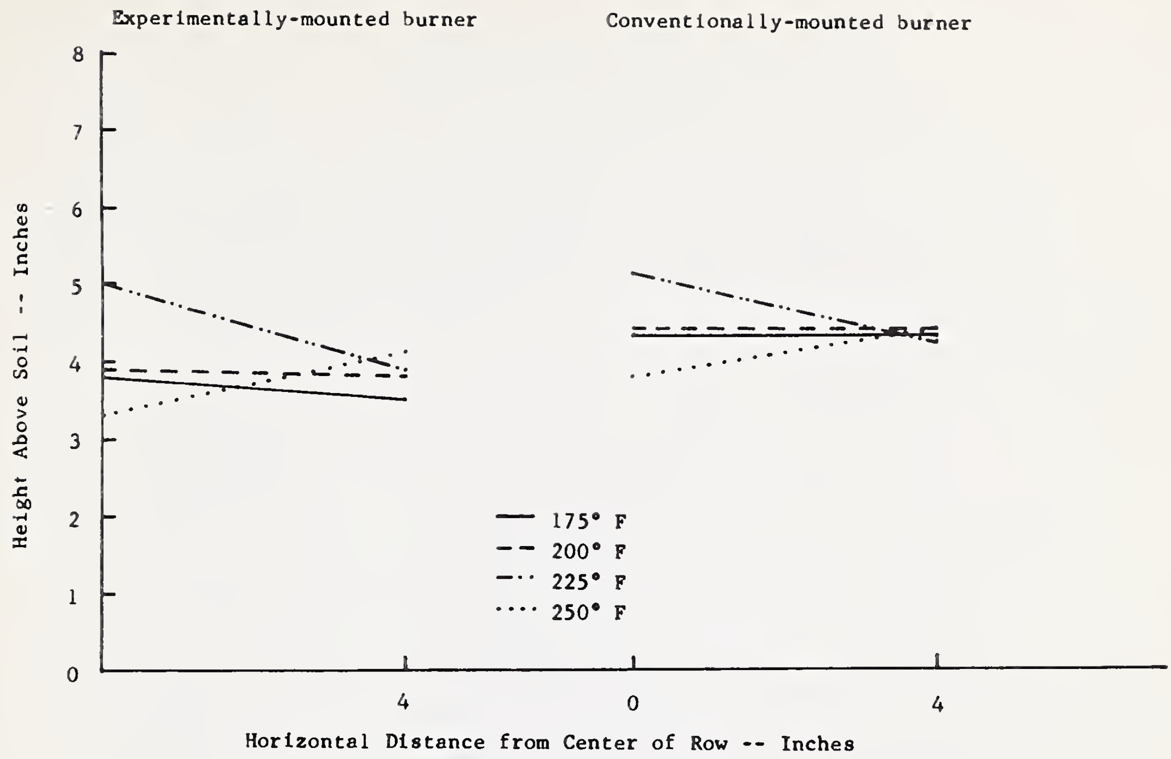

Figure 8. Inches above soil surface at which designated temperatures existed across the row when burners were set at a 30° angle with the horizontal plane.

An advantage in mounting individual burners on cultivator beams was evident when the burners were set at a 45° angle. The results obtained with all burners set at 45° are presented in table 2. Although not apparent in figure 9 which illustrates the table, temperatures of 225° and 250°F. were not produced over some of the rows when the conventional skid mounted burners were used. In those instances, the distance above the ground at which the lacquer melted was recorded as zero and averaged with the distances recorded for the remainder of the four rows. In such cases, it was apparent that the hot part of the flame was either passing over the stake or striking the soil surface on the burner side of the outside stake. On the other hand, when the burners were mounted individually, temperatures ranging from 175° to 250°F. were recorded from 0 to 4 inches from the center of the row in all cases.

Table 2. Height from soil surface at which designated temperature exists when burners were set at a 45° angle with the horizontal plane, Stoneville, Miss., July 1961.1/

Flame cultivator	Temperature	Distance from center of row			
		0	2	4	Average
	°F.	in.	in.	in.	in.
Experimental					
burner mounting	175	6.4	7.3	7.5	7.1
	200	6.2	6.4	6.6	6.4
	225	5.6	5.8	5.5	5.6
	250	4.4	4.9	4.6	4.6
					5.9
Conventional					
burner mounting	175	5.9	6.5	6.5	6.3
	200	6.2	5.8	6.2	6.1
	225	3.2	3.9	4.6	3.9
	250	2.8	2.6	3.6	3.0
					4.8

1/ Average over 4 consecutive rows. The difference between the cultivators and between the temperatures is highly significant. The higher temperatures existed closer to the soil surface.

As expected, the hotter temperatures existed closer to the soil surface for both cultivators. A comparison of averages from tables 1 and 2 indicated that lethal temperatures existed over a higher band above the soil surface when the burners were set at the 45° angle than when they were set at the 30° angle. It should be noted, however, that the data for the 45° setting were recorded on a different day and the difference between the two settings could have been caused by different wind velocities. The entire test was performed in the same field.

Conclusion drawn from field tests: For burner settings at 30° angle and conditions existing as described in the text, the method of gaging the flame burners individually resulted in control of the flame as accurate as when the burners were mounted on conventional skids. When the burners were set at a 45° angle, a more accurate control of the flame was obtained by mounting the burners individually. The system of mounting burners individually allows burners to remain at a constant distance above their respective rows. Cost advantages for combining a flame cultivator with a mechanical cultivator are evident without field tests.

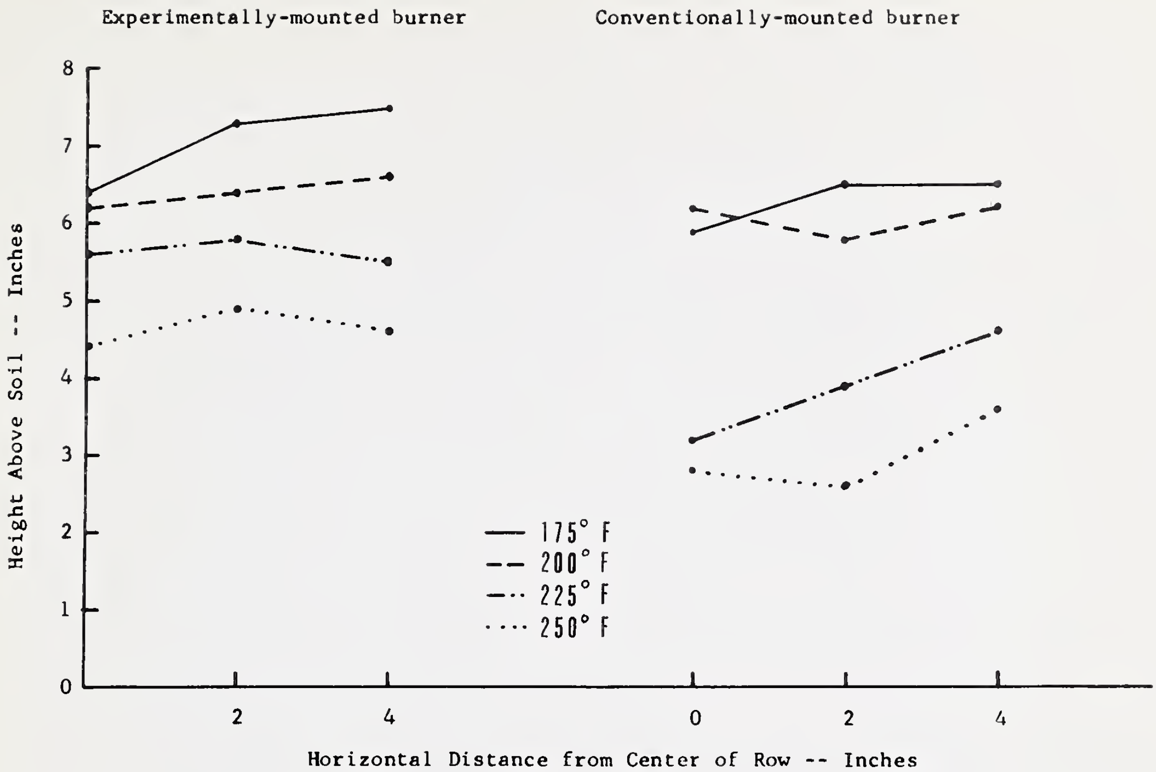

Figure 9. Inches above soil surface at which designated temperatures existed across the row when burners were set at a 45^{o} angle with the horizontal plane.

Because of certain uncontrollable elements (such as flame fluctuation and wind movement), one may expect temperatures ranging from 175^{o} to 250^{o}F. to exist within a vertical plane with boundaries of 4 inches on each side of the cotton plant and 4 inches above the soil surface when burners are set at 30^{o} angle. These temperatures may exist somewhat higher above the soil surface when the burners are set at 45^{o} angle.

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